No. 8300150

# THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

## Michigan Agricultural Experiment Station

Whereas, THERE HAS BEEN PRESENTED TO THE

**Secretary of Agriculture**

AN APPLICATION REQUESTING A CERTIFICATE OF PROTECTION FOR AN ALLEGED NOVEL VARIETY OF SEXUALLY REPRODUCED PLANT, THE NAME AND DESCRIPTION OF WHICH ARE CONTAINED IN THE APPLICATION AND EXHIBITS, A COPY OF WHICH IS HEREUNTO ANNEXED AND MADE A PART HEREOF, AND THE VARIOUS REQUIREMENTS OF LAW IN SUCH CASES MADE AND PROVIDED HAVE BEEN COMPLIED WITH, AND THE TITLE THERETO IS, FROM THE RECORDS OF THE PLANT VARIETY PROTECTION OFFICE, IN THE APPLICANT(S) INDICATED IN THE SAID COPY, AND WHEREAS, UPON DUE EXAMINATION MADE, THE SAID APPLICANT(S) IS (ARE) ADJUDGED TO BE ENTITLED TO A CERTIFICATE OF PLANT VARIETY PROTECTION UNDER THE LAW.

NOW, THEREFORE, THIS CERTIFICATE OF PLANT VARIETY PROTECTION IS TO GRANT UNTO THE SAID APPLICANT(S) AND THE SUCCESSORS, HEIRS OR ASSIGNS OF THE SAID APPLICANT(S) FOR THE TERM OF eighteen YEARS FROM THE DATE OF THIS GRANT, SUBJECT TO THE PAYMENT OF THE REQUIRED FEES AND PERIODIC REPLENISHMENT OF VIABLE BASIC SEED OF THE VARIETY IN A PUBLIC REPOSITORY AS PROVIDED BY LAW, THE RIGHT TO EXCLUDE OTHERS FROM SELLING THE VARIETY, OR OFFERING IT FOR SALE, OR REPRODUCING IT, IMPORTING IT, OR EXPORTING IT, OR USING IT IN PRODUCING A HYBRID OR DIFFERENT VARIETY THEREFROM, TO THE EXTENT PROVIDED BY THE PLANT VARIETY PROTECTION ACT. NOTICE: UNITED STATES SEED OF THIS VARIETY (1) SHALL BE SOLD BY VARIETY NAME ONLY AS A CLASS OF CERTIFIED SEED AND (2) SHALL CONFORM TO THE NUMBER OF GENERATIONS ALLOWED BY THE OWNER OF THE RIGHTS. (84 STAT. 1542, AS AMENDED, 7 U.S.C. 2321 ET SEQ.)

BEAN

'C-20'

In Testimony Whereof, *I have hereunto set my hand and caused the seal of the* Plant Variety Protection Office *to be affixed at the City of* Washington *this* 31st *day of* May *in the year of our Lord one thousand nine hundred and* eighty-five.

Attest:

Kenneth A. Evans
Commissioner
Plant Variety Protection Office
Agricultural Marketing Service

John R. Block
Secretary of Agriculture

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE
LIVESTOCK, POULTRY, GRAIN & SEED DIVISION

FORM APPROVED
OMB NO. 40 R3822

# APPLICATION FOR PLANT VARIETY PROTECTION CERTIFICATE

**INSTRUCTIONS:** *See Reverse.*

No certificate for plant variety protection may be issued unless a completed application form has been received (5 U.S.C. 553).

| 1a. TEMPORARY DESIGNATION OF VARIETY | 1b. VARIETY NAME | FOR OFFICIAL USE ONLY |
|---|---|---|
| MSU Strain # N80100 | C-20 | PV NUMBER 8300150 |
| 2. KIND NAME: Navy (Pea) Bean | 3. GENUS AND SPECIES NAME: Phaseolus vulgaris L. | FILING DATE 6/17/83 / TIME 8:30 A.M. XXX P.M. |
| 4. FAMILY NAME (BOTANICAL): Leguminosae | 5. DATE OF DETERMINATION: Dec. 1982 | FEE RECEIVED $ 1,000 / $ 500.00 / DATE 6/17/83 / 4/9/85 |
| 6. NAME OF APPLICANT(S): Michigan Agricultural Experiment Station | 7. ADDRESS (*Street and No. or R.F.D. No., City, State, and ZIP Code*): MSU, E. Lansing, MI 48824-1114 | 8. TELEPHONE AREA CODE AND NUMBER: (517) 353-9545 |
| 9. IF THE NAMED APPLICANT IS NOT A PERSON, FORM OF ORGANIZATION: (*Corporation, partnership, association, etc.*) State - Federal Institution | 10. IF INCORPORATED, GIVE STATE AND DATE OF INCORPORATION | 11. DATE OF INCORPORATION |

12. NAME AND MAILING ADDRESS OF APPLICANT REPRESENTATIVE(S), IF ANY, TO SERVE IN THIS APPLICATION AND RECEIVE ALL PAPERS:
Dr. L.O. Copeland, Professor, Dept. of Crop and Soil Sciences
MSU, E. Lansing, Michigan 48824-1114

13. CHECK BOX BELOW FOR EACH ATTACHMENT SUBMITTED:

- [X] 13A. Exhibit A, Origin and Breeding History of the Variety *(See Section 52 of the Plant Variety Protection Act.)*
- [X] 13B. Exhibit B, Novelty Statement.
- [X] 13C. Exhibit C, Objective Description of the Variety *(Request form from Plant Variety Protection Office.)*
- [X] 13D. Exhibit D, Additional Description of the Variety.

14a. DOES THE APPLICANT(S) SPECIFY THAT SEED OF THIS VARIETY BE SOLD BY VARIETY NAME ONLY AS A CLASS OF CERTIFIED SEED? *(See Section 83(a). (If "Yes," answer 14B and 14C below.)* [X] YES [ ] NO

14b. DOES THE APPLICANT(S) SPECIFY THAT THIS VARIETY BE LIMITED AS TO NUMBER OF GENERATIONS? [X] YES [ ] NO

14c. IF "YES," TO 14B, HOW MANY GENERATIONS OF PRODUCTION BEYOND BREEDER SEED? [ ] FOUNDATION [ ] REGISTERED [X] CERTIFIED

15a. DID THE APPLICANT(S) FILE FOR PROTECTION OF THIS VARIETY IN OTHER COUNTRIES? [ ] YES [X] NO *(If "Yes," give name of countries and dates.)*

15b. HAVE RIGHTS BEEN GRANTED THIS VARIETY IN OTHER COUNTRIES? [ ] YES [X] NO *(If "Yes," give name of countries and dates.)*

16. DOES THE APPLICANT(S) AGREE TO THE PUBLICATION OF HIS/HER (THEIR) NAME(S) AND ADDRESS IN THE OFFICIAL JOURNAL? [X] YES [ ] NO

17. The applicant(s) declare(s) that a viable sample of basic seed of this variety will be furnished with the application and will be replenished upon request in accordance with such regulations as may be applicable.

The undersigned applicant(s) is (are) the owner(s) of this sexually reproduced novel plant variety, and believe(s) that the variety is distinct, uniform, and stable as required in Section 41, and is entitled to protection under the provisions of Section 42 of the Plant Variety Act.

Applicant(s) is (are) informed that false representation herein can jeopardize protection and result in penalties.

4/11/83 (DATE) — L.O. Copeland (SIGNATURE OF APPLICANT)

(DATE) — (SIGNATURE OF APPLICANT)

FORM GR-470 (1-78)

EXHIBIT A

ORIGIN AND BREEDING HISTORY OF THE VARIETY, C-20

C-20 navy bean (Phaseolus vulgaris L.) originated from a three-way cross made in 1976 between the varieties:

JAMAPA / NEP-2 //73130-E2-B, W-20 / KENTWOOD

The cross was coded 76076 and was advanced using single seed descent to $F_4$ generation. Breeding line 76076-D6 was identified and selected as a single $F_4$-row in Ohio, and reselected as a single $F_5$-row in Sinaloa, Mexico. Line 76076-D6-B entered preliminary yield trials in 1979 and was selected as the highest yielding line among 117 lines under test.

In 1980, 76706-D6-B was released to Michigan State University by Campbell Soup Co. as an $F_7$-generation navy bean breeding line: coded C-20. It received the MSU Accession code N80100 and has been tested for 3 years over 15 locations in Michigan. Additional testing for yield has been conducted in ND, NY, and Ontario and disease testing in WA, WI, CO, NB, and ND.

C-20 was officially named and approved for release in December 1982.

8300150

Exhibit A. addendum rec'd 9/14/84.

C-20 is a pure line cultivar developed in a self-pollinated crop species (Phaseolus vulgaris L.). As a self-pollinating pure line cultivar, C-20 is genetically uniform and will breed true and remain stable with no deviation from uniformity over time. C-20 has been inbred 6 generations from the original $F_5$ generation selection made in 1978.

Exhibit B. addendum

Fleetwood is the 'most similar' of the current navy bean cultivars to C-20. Only those statements made in the novelty statement refering to comparisons of C-20 with Fleetwood should be considered.

Exhibit C. addendum

C-20 differs from Swan Valley, Saginaw and Chief in the characteristics listed below.

| Character | Cultivars | |
|---|---|---|
| | C-20 | Swan Valley |
| Seed Size: | 20 g/100 seeds | 18 g/ 100 seeds |
| Seed color (L-Scale)*: | 62.7 | 59.0 |
| Maturity: | 8 days later than Sanilac | 12 days later than Sanilac |
| Regression coeff. (b) for yield stability: | 1.03 | 1.39 |

* Seed color measured using Hunter Color Meter.

| | C-20 | Saginaw |
|---|---|---|
| Maturity: | 8 days later than Sanilac | 2 days later than Sanilac |
| Anthracnose: | alpha-S<br>delta-R | alpha-R<br>delta-S |
| Plant Habit**: | Upright Type-II | Prostrate Type-III |

| | C-20 | Chief |
|---|---|---|
| Seed Size: | 20 g/100 seeds | 18 g/100 seeds |
| Anthracnose: | delta-R | delta-S |
| Plant Habit**: | Upright Type-II | Prostrate Type III |

** The classification of plant habit as indeterminate does not adequately distinguish between short vine upright types known as the Type-II plant habit from the long CR vined prostrate Type-III plant habit. The classification of plant habit into 4 classes Type I, II, III, IV as described in the attached article by Dr. Singh of CIAT allows a clearer distinction between the 3 types of indeterminacy i.e. Type II, III and IV. The adoption of this classification in addition to current description of 4 Type I bushes would greatly aid in the differentiation of bean cultivars for plant habit.

EXHIBIT B

NOVELTY STATEMENT See addendum of 9/14/84

1. C-20 represents a navy bean cultivar developed upon the ideotype concept. The concept states that certain modified plant architectural features should permit better light penetration of canopy, planting in narrow rows and direct harvest in order to maximize yield potential. C-20 possesses many of these features and the modified plant architecture, 'architype' which distinguishes it from standard bush navy bean cultivars.

2. C-20 has a type II, upright short vine plant habit compared to type I determinate bush habit of standard cultivars (Item 1, Table 2). The plants are taller (Item 2, Table 2), more erect, narrow in profile with fewer basal branches. The stiff stem and deep taproot contribute to its resistance to lodging (Item 3, Table 2) as compared to the standard cultivars (Sanilac, Seafarer and Fleetwood).

3. C-20 is later flowering and maturing (Item 4 and 5, Table 2) and possesses greater yield stability (Item 7, Table 1) than the other 3 cultivars.

4. C-20 carries resistance to the delta strain of anthracnose (Item 3, Table 3) to which all the standard cultivars are susceptible.

5. C-20 is resistant to indigenous rust races prevalent in Michigan to which Sanilac and Seafarer are very susceptible. In addition, C-20 is resistant to races in NB and CO to which Fleetwood is susceptible (Item 2, Table 3).

6. C-20 carries tolerance to ozone air pollution, present annually in MI (Item 4, Table 3). All the standard cultivars are susceptible to ozone.

7. C-20 possesses field tolerance to white mold as shown by yield increase over susceptible standard varieties under conditions of severe white mold infection (Item 5, Table 1).

8. C-20 carries field tolerance to strains of Fusarium root rot present in WI and WA (Item 6, Table 3). The Seafarer and Fleetwood varieties are considerably more susceptible.

9. The seed and cooking characteristics of C-20 indicate that it possesses the same quality attributes required of all acceptable navy bean cultivars.

FORM APPROVED: OMB NO. 40-R3822

U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE
LIVESTOCK, POULTRY, GRAIN & SEED DIVISION
BELTSVILLE, MARYLAND 20705

EXHIBIT C
*(Bean)*

# OBJECTIVE DESCRIPTION OF VARIETY

*BEAN (Phaseolus vulgaris L.)*

NAME OF APPLICANT(S)
Michigan Agricultural Experiment Station

ADDRESS *(Street and No. or R.F.D. No., City, State, and Zip Code)*
Michigan State University
E. Lansing, Michigan 48824-1114

FOR OFFICIAL USE ONLY

PVPO NUMBER **8300150**

VARIETY NAME OR TEMPORARY DESIGNATION

Place numbers in the boxes (e.g. [0][8][9]) for the characters that best describe this variety. Measured data should be for SPACED PLANTS. Ranges may also be given. Royal Horticultural Society or any recognized color standard may be used to determine plant colors; designate system used: Michigan. The location of test area is Saginaw. Please answer questions appropriate for your variety if the information is available.

**1. TYPE:**

[ ] 1 = Field *(dry-edible)*  2 = Garden

**2. MARKET MATURITY:**

[ ][ ] Days to edible pods

[ ][ ] Days to green shells

[1][0][0] Days to dry seeds

[ ][ ][.][ ] Heat units to edible pods

[ ][ ][ ][ ] Heat units to green shells

[1][6][1][5] Heat units to dry seeds

[ ][ ] No. days earlier than ..... [ ]

..... Same as .. [ ]

[ ][8] No. days later than ..... [8]

1 = Tendercrop
2 = Kentucky Wonder
3 = Kinghorn Wax
4 = White Kidney
5 = Michelite 62
6 = Dwarf Horticultural
7 = Bush Blue Lake 290
8 = Other (specify below)
Sanilac

**3. PLANT:**

[2] 1 = Determinate  2 = Indeterminate

[ ][5][0] cm height

[ ][ ] cm shorter than ..... [ ]

Same as .. [ ]

[0][8] cm taller than ..... [8]

comparison variety from above

[4][0] cm spread

[ ][ ][3] Number primary branches near base

[0][5] cm narrower than ..... [8]

width same as ... [ ]

[ ][ ] cm wider than ..... [ ]

comparison variety from above

[1] Branching habit: 1 = compact  2 = open

[2] Main stalk: 1 = brittle  2 = wirey

[1] 1 = stout  2 = thin

3. PLANT: (Cont'd)

[2] Pod position: 1 = low 2 = high 3 = scattered

[5] Bush form (illustrated below):

1 = spherical bush form 2 = stem bush form 3 = wide bush form 4 = high bush form

5 = other (specify) Upright Short Vine

4. LEAVES:

[1] 1 = smooth 2 = wrinkled

[1] 1 = dull 2 = glossy

[2] Size: 1 = small (Earliwax) 2 = medium 3 = large (Tendercrop)

[2] Color: 1 = light green (as light or lighter than Bountiful) 2 = medium green
3 = dark green (as dark or darker than Bush Blue Lake 290)

5. FLOWERS:

[1] Color: 1 = white 2 = cream 3 = pink 4 = lilac 5 = purple 6 = Other (specify)_____

[4][7] Days to 50% bloom

6. FRESH PODS: (Edible maturity, average for 20 pods)

[ ] Exterior color: 1 = light green (as light or lighter than Bountiful)
2 = medium green
3 = dark green (as dark or darker than Bush Blue Lake 290)
4 = light yellow (Brittlewax)
5 = golden yellow (Cherokee Wax)
6 = green-red variagated (Horticultural)
7 = other (specify)

_____

% Sieve size distribution at optimum maturity for non-flat pods

Note:
1 = 4.76 mm to 5.76 mm
2 = 5.76 mm to 7.34 mm
3 = 7.34 mm to 8.34 mm
4 = 8.34 mm to 9.53 mm
5 = 9.53 mm to 10.72 mm
6 = 10.72 mm or larger

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| | | | | | |

| | | | |
|---|---|---|---|
| 3 sieve | [ ][ ] cm length | [ ][ ] mm width | [ ][ ] mm thickness |
| 4 sieve | [ ][ ] cm length | [ ][ ] mm width | [ ][ ] mm thickness |
| 5 sieve | [ ][ ] cm length | [ ][ ] mm width | [ ][ ] mm thickness |
| 6 sieve | [ ][ ] cm length | [ ][ ] mm width | [ ][ ] mm thickness |

6. **FRESH PODS: (Cont'd)**

[ ] Cross section pod shape: 1 = flat 2 = oval 3 = round 4 = heart

[ ] Creaseback: 1 = present 2 = absent

[ ] Pubescence: 1 = none 2 = sparse 3 = considerable

[ ] Spur: 1 = straight 2 = slightly curved 3 = curved

[ ] Constrictions: 1 = none 2 = slight 3 = deep

[ ] Pod flesh: 1 = light 2 = medium 3 = dark

[ ][ ] mm spur length

[ ] Fiber: 1 = none 2 = sparse 3 = considerable

[ ] Number of seeds per pod

[ ] Surface: 1 = smooth 2 = rough

[ ] Suture string: 1 = present 2 = absent

[ ] Seed development (Snap Bean): 1 = slow 2 = medium 3 = fast

[ ] Machine harvest: 1 = adapted 2 = not adapted

[ ] Pod flavor: (1) Standard (Tendercrop)
(2) Mild Blue Lake (BBL 274)
(3) Strong Blue Lake (Pole FM1)
(4) Mild Romano (Roma)
(5) Strong Romano (Pole Romano)
(6) Other (specify) _____

7. **SEED COAT COLOR:**

[1] 1 = Monochrome 2 = Polychrome [2] 1 = shiny 2 - dull

[1] Primary color: 1 = white 2 = yellow 3 = buff 4 = tan

[ ] Secondary color: 5 = brown 6 = pink 7 = red 8 = purple
9 = blue 10 = black 11 = other (specify) _____

[1] Color Pattern: 1 = none 2 = splashed 3 = mottled 4 = striped 5 = flecked 6 = dotted

[ ] Secondary color location: 1 = hilar ring 2 = ventral surface
3 = sides 4 = dorsal surface
5 = not restricted to any area 6 = combination of location (specify below)

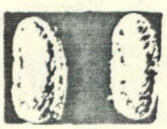
_____

[1] Hilar ring on colored seeds: 1 = absent 2 = narrow 3 = butterfly shaped

8. **SEED SHAPE AND SIZE:**

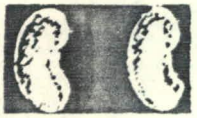
[2] Hilum view: 1 = elliptical 2 = oval 3 = round [2] Cross section: 1 = elliptical 2 = oval 3 = cordate 4 = round

[2] Side view:



1 = oval to oblong

2 = round



3 = reniform

**8. SEED SHAPE AND SIZE: (Cont'd)**

[2] 1 = truncate ends 2 = rounded ends

[2][0] gm/100 seed

[ ][ ] gm/100 seed lighter than . . . . . [ ]

gm/100 seed same as . . . . [ ] comparison variety from page one

[ ][1] gm/100 seed heavier than . . . . . [8]

**9. ANTHOCYANIN: (1 = absent 2 = present)**

[1] Flowers [1] Stems [1] Pods [1] Seeds [1] Leaves

**10. DISEASE RESISTANCE (0 = not tested 1 = susceptible 2 = resistant):**

[2] Anthracnose (specify race below) Beta, Gamma, Delta

[2] Rust (specify race below) Indigenous-MI-ND-CO-NB races in

[0] Powdery mildew

[2] Fusarium root rot

[0] Pythium root rot

[0] Rhizoctonia root rot

[0] Pythium wilt

[2] Angular leaf spot

[0] Bacterial wilt

[2] Halo blight (specify race below) Races 1 & 2

[1] Fuscous blight

[0] Red node virus

[0] Pod mottle virus

[2] Bean common mosaic virus (specify strain below) Type, NY-15

[2] Mosaic mottle

[1] Black root

[0] Bean yellow mosaic virus

[0] Curly top

[ ] Other (specify below)

**11. INSECT RESISTANCE: (0 = not tested 1 = susceptible 2 = resistant)**

[1] Aphids

[0] Leaf hopper

[0] Lygus

[0] Pod borer

[0] Root knot nematode

[0] Seed corn maggot

[0] Thrips

[0] Weavils

[ ] Other (specify below)

**12. PHYSIOLOGICAL RESISTANCE: (0 = not tested 1 = susceptible 2 = resistant)**

[0] Heat [0] Cold [0] Drought [2] Air pollution

**13. COMMENTS:**

EXHIBIT D

ADDITIONAL DESCRIPTION OF VARIETY

TABLE 1. COMPARISONS OF YIELD CHARACTERISTICS OF C-20 WITH THREE STANDARD NAVY BEAN CULTIVARS

| Yield (lb/A) | C-20 | Sanilac | Seafarer | Fleetwood |
|---|---|---|---|---|
| 1. Michigan: 4 years/16 locations | 2456 | 1949 | 1844 | 2038 |
| 2. Ontario: 1 year/3 locations | 3202 | — | 2601 | 3132 |
| 3. N. Dakota: 2 years/8 locations | 2441 | — | — | 2167 |
| 4. N. York: 1 year/3 locations | 2628 | 2382 | 2317 | 2409 |
| Yield as percent of: | | | | |
| 5. Seafarer check 4 years/16 locations | 133 | 106 | 100 | 111 |
| 6. Seafarer check infected with white mold | 159 | 104 | 100 | 115 |
| 7. Yield Stability 3 year/14 location | | | | |
| Regression Coeff (b) | 1.03 | 1.14 | 1.16 | 0.79 |
| Coeff of determination ($r^2$) | 0.71 | 0.72 | 0.83 | 0.59 |

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Table 1. Yield Characteristics

Item #1. Yield in Michigan

C-20 has consistently outyielded the standard navy bean varieties in the state of MI by up to 6 cwt/acre over the last 4 seasons and 6 locations.

Item #2-4. Yield in ND, NY and Ontario

Similar results have been obtained from cooperators in NY, ND and Ontario

Item #5. Yield as Percent of Check Cultivar

When yield is compared as a % check variety Seafarer, C-20 has a yield advantage of 33%. This represents a better comparison for farmer/growers who might not always achieve the actual high yields observed in test plots, but who might want to anticipate the potential yield advantage of cultivar for their own farming system.

Item #6. Yield as Percent of Check when Infected with White Mold

In plots, infected naturally with white mold, C-20 showed a further significant yield increase over Seafarer from 33% to 59%. These data indicates that C-20 carries field tolerance to this pathogen while the other cultivars are very susceptible.

Item #7. Yield Stability

Yield stability is determined by simple regression analysis of cultivar yield against an environment index (based on mean yield of other cultivars at that environment) across diverse environments and seasons. The two parameters measured are the regression coefficient (b) and the coefficient of determination ($r^2$) i.e. square of correlation coefficient.

When $b \approx 1$; indicates a cultivar is uniformly responsive to all environments, whether productive or not. The value of unity indicates that a cultivar demonstrates yield stability irregardless of the productivity of the environment.

When $b > 1$; indicates a cultivar is responsive only to productive environments and is significantly less productive in poor environments.

When $b < 1$; indicates a cultivar is not responsive to improved or productive environments but maintains higher productivity under poorer environments.

The coefficient of determination ($r^2$) indicates the predictability of the regression coefficient. The higher the value the better is the line of best fit to all the data points. Lower values indicate considerable scatter of data points around the regression line.

A regression coefficient of $b = 1.03$ for C-20, indicates the stability of the cultivar across the environments tested. Seafarer and Sanilac are more responsive only to more productive environments with values of $b = 1.16$ and 1.14, respectively. Fleetwood with a low value $b = 0.79$ indicates

that this cultivar is not responsive to productive environments but yields better in poor environments. The low value of coefficient of determination ($r^2 = 0.59$) for Fleetwood indicates considerable variability between data points for this cultivar. C-20, Sanilac and Seafarer show good fit to the regression line based on higher $r^2$ values.

TABLE 2. COMPARISON OF PLANT CHARACTERISTICS OF C-20 WITH THREE STANDARD NAVY BEAN CULTIVARS

| | C-20 | Sanilac | Seafarer | Fleetwood |
|---|---|---|---|---|
| 1. Plant Type | II | I | I | I |
| 2. Height (cm) | 50 | 42 | 40 | 44 |
| 3. Lodging Score | 2.5 | 3.0 | 3.0 | 4.0 |
| 4. Maturity-days | | | | |
| Average | 100 | 92 | 85 | 97 |
| Range | 98-104 | 89-94 | 83-94 | 95-110 |
| 5. Flowering Days | 47 | 42 | 38 | 44 |

Table 2. Plant Characteristics

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Item #1. Plant Type

C-20 has a type II, upright short vine plant habit. It differs from standard cultivars which are multibranched Type I determinate bush types. The plant type is refered to as an 'architype' - architectural plant type, because upright narrow profile and limited basal branches.

Item #2. Height

C-20 is taller (data collected at maturity) than standard navy bean cultivars.

Item #3. Lodging

C-20 shows more resistance to lodging particulary compared to Fleetwood which tends to lodge the worst.

Item #4. Maturity

C-20 is a full-season variety for Michigan maturing 100 days from planting. Depending on the season and/or location, maturity can vary from 98-104 days. C-20 is approximately a week later than the mid-season variety Sanilac and 2 weeks later than early-season variety Seafarer. C-20 is in the same maturity class as Fleetwood which generally matures 3 days earlier but can vary considerably, depending upon season and/or location.

Item #5. Flowering Date

C-20 is a few days later in flowering date than other cultivars. The delay in flowering permits the cultivar to develop a bigger more vigorous root and stem structure, fundamental for production of more yield as increased pod number and seeds per pod.

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TABLE 3. COMPARISON OF DISEASE CHARACTERISTICS OF C-20 WITH THREE STANDARD NAVY BEAN CULTIVARS

| | C-20 | Sanilac | Seafarer | Fleetwood |
|---|---|---|---|---|
| 1. Bean Common Mosaic Virus | | | | |
| Type | R | R | R | R |
| NY-15 | R | S | R | R |
| NL-3 | BR | S | BR | BR |
| 2. Rust (Indigenous Races) | | | | |
| MI | HR | VS | VS | R |
| ND | R | — | MR | S |
| NB | I | — | S | MS |
| CO | I | — | VS | R |
| 3. Anthracnose | | | | |
| Alpha | S | R | R | R |
| Beta | R | R | R | R |
| Gamma | R | R | R | R |
| Delta | R | S | S | S |
| 4. Air Pollution Ozone | T | VS | VS | S |
| 5. White Mold | T | VS | VS | VS |
| 6. Root Rot (Fusarium) WA, WI | T | — | S | S |

I = Immune; R = Resistant (H= Highly, M= Moderate); S = Susceptible (V=Very); T = Field Tolerance; BR = Black Root, Hypersensitive Resistant Reaction.

Table 3. Disease Characteristics

Item #1. Bean Common Mosaic Virus - (BCMV)

C-20 carries the dominant 'I' gene for resistance to all strains of BCMV. It is resistant to common strains (Type and NY-15) present in Michigan and develops the hypersensitive black root or top necrosis reaction when infected with necrotic virus strains like NL-3. Seafarer and Fleetwood carry the same resistance gene while Sanilac with recessive resistance, is susceptible to NY-15 and NL-3 necrotic strain.

Item #2. Rust -(Uromyces phaseoli)

C-20 carries dominant genetic resistance to indigenous strains of rust prevalent in MI, ND, NB and CO. Sanilac and Seafarer are very susceptible to the indigenous strains in Michigan and Fleetwood is susceptible to the races in ND and NB.

Item #3. Anthracnose -(Colletotrichum lindemuthianum)

C-20 carries resistance to the beta, gamma and delta races of anthracnose, although susceptible to the alpha race. The three other cultivars are resistant to the alpha, beta, gamma races but susceptible to the virulent delta race.

Item #4. Air Pollution -(Ozone)

C-20 is tolerant to oxidant air pollution present in Michigan. Sanilac and Seafarer are very susceptible to ozone pollution and suffer yield losses and premature defoliation as a result. Fleetwood although susceptible is also damaged but to a lesser degree.

Item #5. White Mold -(Sclerotinia sclerotiorum)

C-20 has shown field tolerance to natural infection of white mold. C-20 showed a yield increase over Seafarer from 33% with no white mold to 59% under condition of severe white mold infection (Item #6, Table 1). The cultivar, although, becoming infected with the pathogen, does not suffer the severe yield reduction as shown by the other three cultivars.

Item #6. Root Rot -(Fusarium solani)

C-20 has shown field tolerance to natural strains of Fusarium root rot present in bean trial grounds in WA and WI. C-20 has a low disease index of 37 compared to values of 70 and 63 for Seafarer and Fleetwood, respectively.

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TABLE 4. COMPARISON OF SEED CHARACTERISTICS OF C-20 WITH STANDARD NAVY BEAN CULTIVARS

| | C-20 | Sanilac | Seafarer | Fleetwood |
|---|---|---|---|---|
| 1. Seed Size #100 seed weight (g) | 19.2 | 18.2 | 20.5 | 18.2 |
| 2. Dry Seed Color Hunter L-scale | 62.7 | 61.4 | 62.1 | 63.4 |
| Processing and Canning Data | | | | |
| 3. Processed color Hunter L-scale | 50.1 | 50.6 | 52.5 | 52.1 |
| 4. Hydration Ratio | 1.91 | 1.97 | 1.81 | 1.94 |
| 5. Drained Weight Ratio | 1.51 | 1.39 | 1.44 | 1.44 |
| 6. Texture | 42.5 | 48.8 | 44.9 | 56.7 |

Table 4. Seed Characteristics

Item #1. Seed Size

Seed size in dry beans is determined by 100-seed weight. No significant variation exists for seed size between C-20 and the 3 standard cultivars.

Item #2. Dry Seed Color

In order to ensure that whiteness of seed coat is satisfactory, the dry seed color is determined using the L-scale of a Hunter Color Meter. No significant difference exists for seed color between C-20 and the 3 standard cultivars.

Items #3-6. Processing and Canning Data

These data presented on the canning quality characteristics required of navy beans, show no significant differences for any of the characteristics between C-20 and the 3 standard cultivars. The processed color, hydration ratio, drained weight ratio, and texture as measured by shear force applied to the cooked sample, indicate that C-20 is well within the acceptable limits for all these processing characteristics.